The Impact of the Risk-Based Capital Reform in the Insurance Industry on Corporate Financing

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Abstract

I investigate how the risk-based capital (RBC) reform in the insurance industry initiated in year 1993 affect life insurers' investment behaviour in corporate bonds, and how RBC-induced distortion in insurers' investment practices could have an impact on credit allocation, and ultimately real investment in the economy. Following the reform, I observe that insurers tilt their portfolios towards lowest rated corporate bonds within a bond risk category defined by the RBC rule. Through shifting insurers' bond demand, I find that the RBC reform changes the credit supply conditions to a particular group of firms: those that have credit ratings barely fitting into a low risk category, and belong to industries where insurers hold more corporate bonds prior to the reform. Furthermore, I find that these firms take advantage of the more favorable credit allocation conditions to increase investment and employment after the reform. These results highlight a channel through which the regulatory reform in the insurance industry can bear real consequences.

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1 Introduction

The U.S. insurance industry is regulated under the National Association of Insurance Commissioners (NAIC) risk-based capital (RBC) system. The RBC requires an insurance company with a riskier profile to reserve a higher amount of capital as a cushion against insolvency. The purpose of the RBC regulation is to limit the amount of risk insurance companies can take in their insurance products and asset investments. A growing body of literature has documented that the design of the RBC rules could give rise to distortions in insurers' behavior (see, for example, Koijen and Yogo (2015), Ellul, Jotikasthira, and Lundblad (2011), Ellul et al. (2015), and Becker and Ivashina (2015)).[1]

In the context of corporate bonds, this paper explores how the RBC could influence life insurers' asset investment behavior at its very initiation in year 1993, and how RBC-induced distortion in insurers' investment practices could generate shifts in credit allocation. I develop empirical tests to assess how the RBC-driven shift in credit supply would affect price and quantity of credit, and furthermore, firms' real investment in the economy. The motivation to focus on the impact of the RBC regulation that governs life insurers' investment in corporate bonds is multifold. First, life insurance companies invest 40% of their financial assets in corporate and foreign bonds,[2] thereby rendering the treatment of corporate bonds the key element in the RBC calculation. Second, life

[1] Koijen and Yogo (2015) and Ellul et al. (2015) find that the RBC regulation interacted with accounting rules could bear unintended consequences. Koijen and Yogo (2015) show that life insurers may boost their regulatory capital positions in the short run through selling policies at deep discounts relative to actuarial value, making them susceptible to insolvency in the long run. Ellul et al. (2015) record that insurers engage in "gains trading" where, to shore up their capital positions, insurers selectively dispose of otherwise unrelated assets with the largest unrealized gains, rather than the troubled assets. Ellul et al. (2011) find evidence that the RBC requirements force regulatory-constrained insurance companies to sell downgraded corporate bonds, inducing fire sales in the bond market. Becker and Ivashina (2015) find that the NAIC RBC's bond classes defined by broad categories of credit ratings lead insurance companies to "reach for yield", i.e., buying the riskier bonds within a bond class to achieve higher yields, in the corporate bond market.

[2] Refer to Table L.116 of the Federal Reserve Flow of Funds at https://www.federalreserve.gov/releases/z1/.

insurers are the largest institutional holders of corporate and foreign bonds, with their holdings accounting for around 25% of the amounts outstanding.[3] Therefore, through its investment activities in corporate bonds, life insurance sector provides a vital source of funding to other sectors of the economy. Third, looking at the setting of the initial adoption of the RBC allows for sharper identification of how regulatory reform of insurance companies would have an impact on credit allocation, and ultimately, real investment in the economy.

To determine the capital requirements for insurers' bond holdings, the NAIC sorts bonds into six risk categories defined by bond credit ratings, with NAIC risk category 1 composed of bonds with the best ratings and category 6 the worst. There are two salient features of the RBC rule. First, the capital requirements increase sharply as one moves to a riskier category. Compared with category 1, bonds in category 2 are charged three times more, and category 6 a hundred times more. Second, the NAIC risk categories are loosely defined: Each category contains bonds with a wide range of credit ratings. In particular, bonds with ratings ranging from AAA to A- are all classified as category 1. While the first feature of the RBC rule limits risk-taking through deterring insurers from investing in worse-rated bonds in riskier categories, the second feature leaves insurers room to acquire riskier bonds to achieve higher yields within a given NAIC risk category, however, without being charged additional capital reserve.[4] Consequently, the impact of the RBC can manifest itself in insurers' increased relative demand for certain bonds. Using NAIC's data on insurers' corporate bond holdings that spans the pre- and post-RBC period from 1991 to 1996,[5] I find that after the RBC reform, life insurers tilt their corporate bond portfolios towards A-rated bonds, which is the lowest tier of NAIC risk category 1. On top of that, the expanded holdings of A-rated bonds are

[3]Refer to Table L.213 of the Federal Reserve Flow of Funds at https://www.federalreserve.gov/releases/z1/.
[4]This is the "reaching for yield" behavior documented in Becker and Ivashina (2015).
[5]The NAIC's earliest available recording of insurance companies' bond holdings starts in year 1991.

more noticeable among insurers that are more constrained by the RBC regulation.

After documenting insurers' increased acquisition of A-rated corporate bonds following the RBC reform, I analyze the implication of the RBC-driven shift in insurers' bond demand on risk premiums. I treat the yield spreads of new bonds at issuance as the relevant risk premiums. There is evidence that the yield spreads on A-rated bonds experience a disproportionate drop after the RBC reform, compared with other risk tiers AAA and AA in NAIC risk category 1 as well as BBB in category 2. The result is consistent with insurers' enhanced demand for A-rated bonds due to the discontinuity of the RBC rule across risk categories and plentiful leeway for risk-taking within a given risk category. This finding suggests that the RBC could have an impact on credit pricing through insurers' distorted bond demand ascribable to RBC's flawed design of risk categories not sensitive enough to risk. A further implication is that corporations who issue bonds that happen to barely meet the criterion for low capital charges would be able to raise funds at lower costs.

In the next set of tests, I examine the implication of the RBC-induced shift in insurers' bond demand on corporate debt issues of non-financial firms, employing a difference-in-difference empirical strategy. I propose to isolate the effect of the RBC reform on debt issuance by studying the differential post-RBC changes across not only firms' credit ratings but also their corresponding industries' varying degrees of dependence on life insurance company funding prior to the RBC reform. The industry-level measure of dependence on insurer financing is defined as the proportion of all outstanding bonds in each four-digit Standard Industrial Classification (SIC) code held by life insurers averaged over the pre-reform period 1991 to 1992. The identification assumption central to this empirical approach is that A-rated firms in industries that are more reliant on insurer financing before the reform would respond more to the shift induced by the RBC reform in credit supply through increasing debt issuance. First, I find that A-rated firms in more insurer-dependent

industries experience a relative increase in long-term debt compared to other investment-grade firms. Moreover, I don't observe a significant change in short-term debt. These findings confirm that RBC's impact operates through driving long-term borrowing, which is consistent with the fact that life insurers are long-term investors given their liability structure. Lastly, I repeat the above analysis, but separate firms into those facing stronger or weaker financial constraints on the basis of dividend payout ratio, operating cash flows, and size. I find that the post-reform increase in long-term debt are especially pronounced among the group of constrained firms. This last result suggests that the RBC relaxes financial constraints for firms that are ex-ante constrained.

In the final set of tests, I investigate the implication of the RBC reform for firms' investment and employment decisions. The results show a relative growth in investment and employment for A-rated firms in more insurer-dependent industries after the reform. What's more, the growth in investment and employment is stronger among the group of firms facing more financial constraints. This observation is consonant with the above finding that ex-ante constrained firms benefit from the RBC reform in that they are able to raise debt issuance thanks to the shift in insurers' demand. Taken together, these findings illustrate a channel through which the regulatory reform on insurance companies can bear real consequences.

The remainder of this paper is organized as follows. Section 2 discusses the details about the NAIC's RBC reform and the hypotheses regarding the reform's impacts. Section 3 presents the data. Section 4 reports changes in corporate bond holdings in insurance companies' portfolios after the reform. The effect of the reform on bond risk premium is reported in Section 5, whereas Section 6 examines the reform's impact on debt issuance. Section 7 evaluates the reform's real implication on firms' investment behavior. Section 8 concludes.

2 The NAIC's RBC reform and the hypotheses

Before the NAIC's RBC reform, the financial condition of an insurance company is evaluated by insurance regulators under the fixed capital standards. Without consideration of the risks embedded in an insurer's insurance products and investment portfolios, the fixed capital standards require an insurance company to maintain the same minimum amount of capital for retaining a business license. As insolvencies of insurance companies became more frequent and severe in the late 1980s and early 1990s, the fixed capital standards were no longer considered as effective in equipping the insurance industry with a safety net against insolvency. As a consequence, the NAIC responded by adopting a RBC system that includes two major components: (1) a RBC formula that generates the regulatory minimum capital requirement; and (2) a RBC model that gives regulators the authority to intervene in accordance with the capital deficiency indicated by the RBC result. Approved by the NAIC in December 1992, the RBC rules came into effect in the 1993 annual statement filed in March 1994 (Webb and Lilly III, 1994).

In contrast with the fixed capital standards, the RBC formula determines the minimum capital requirement based on the risk profile of an insurance company. Companies with a higher level of risk are charged a greater amount of capital. The RBC formula takes into account four broad risk categories that insurance companies face: C-1 Asset risk, C-2 Insurance risk, C-3 Interest rate risk, and C-4 Business risk.[6] The total required RBC is then obtained by adding up the capital requirements for each risk category with a "square root rule" covariance calculation, thereby rewarding diversification across categories of risks.[7] Regulators use the RBC ratio, which is the minimum

[6]C-1 Asset risk arises from default (on bonds or mortgages) or market declines (of stocks). C-2 Insurance risk is associated with product mispricing. C-3 stems from mismatch between assets and liabilities. C-4 Business risk encompasses all other risks not captured in C-1, 2, or 3.

[7]Specifically, the formula for covariance adjustment is $C4 + \sqrt{(C1 + C3)^2 + C2^2}$.

capital level established by the RBC formula divided by a company's actual capital level, to decide whether any regulatory action is in need.[8]

An insurance company's holdings of corporate bonds, which is the primary focus of this paper, fall under C-1 Asset risk. Since bonds are a major investment vehicle for insurers, insurance companies are required to hold enough capital to deal with the risk that bond issuers default on interest or principal payments. The capital requirements for bonds vary by the NAIC risk categories, which are determined by bond credit ratings. There are six NAIC risk categories (1 through 6). Bonds rated AAA/AA/A belong to category 1. Bonds rated BBB are in category 2. Junk bonds rated BB or below are subsequently put into categories 3 to 6. The capital requirements for each risk category in year 1993, the first year in which the NAIC RBC system took effect, are listed in the Table I.

Two features can be observed from Table I. First, as one moves to a riskier category, the capital requirements increase drastically. For each $100 invested, the capital charge for category 1 bonds is $0.3, whereas the capital charge for category 2 bonds triples to $1. The insurer that invests in bonds of category 6 would be charged $30, which is 100 times the capital requirement for category 1 bonds. Second, each NAIC risk category contains a wide credit rating range. Especially for category 1, bonds with credit rating ranging from AAA through A- are treated in the same way.

While the first feature of the RBC rule serves the purpose of restricting insurance companies from investing in bonds with worse credit ratings, the second feature could allow insurers room for "reaching for yield", i.e., acquiring the riskiest bonds within a given category without being charged a higher capital reserve (Becker and Ivashina, 2015). With data on insurance companies'

[8]The higher the RBC ratio, the better capitalized an insurance company is. As the RBC ratio falls below 2, four levels of supervisory interventions can be triggered: company action, regulatory action, authorized control, and mandatory control. For details on what actions need to be taken by the insurer and the regulator in the event of a RBC intervention, please refer to https://www.naic.org/store/free/MDL-312.pdf.

Table I: The NAIC RBC requirements for bonds

NAIC risk category	Credit rating	Capital factor
U.S. Government Bonds		0.00%
NAIC 1: Highest Quality	AAA AA+/AA/AA- A+/A/A-	0.30%
NAIC 2: High Quality	BBB+ BBB BBB-	1.00%
NAIC 3: Medium Quality	BB+ BB BB-	4.00%
NAIC 4: Low Quality	B+ B B-	9.00%
NAIC 5: Lower Quality	CCC+ CCC CCC-	20.00%
NAIC 6: In or Near Default	CC Or Below	30.00%

Notes: This table lists the capital factors for each NAIC risk category. These factors are first used in the NAIC life risk-based capital report for year 1993. See Appendix H of Webb and Lily III (1994).

corporate bond holdings before and after the RBC reform, I am able to directly investigate whether the RBC reform induces insurers take on additional risk, causing the relative demand for certain bonds to rise after the RBC reform. Exploiting the discontinuity of the RBC rule at the boundary between NAIC risk category 1 and 2 as well as the plentiful leeway for risk-taking within category 1, I examine, in particular, whether insurance companies hold more of the A-rated bonds after the RBC reform. As the lowest tier within category 1, bonds rated A could deliver higher yields than those rated AAA or AA, while subject to the same capital requirement. Increased purchase on the part of insurance companies may bear the following two empirical implications:

Hypothesis 1: As insurers' demand for A-rated bond would rise after the RBC reform, the risk

premiums for A-rated bonds would decrease.

Hypothesis 2: Insurers' greater demand for A-rated bonds after the RBC reform would create a shift in supply of credit to individual firms. A-rated firms that are more dependent on life insurance company funding prior to the reform would respond more to the credit supply shock by increasing debt issuance.

3 Data

Data for the empirical tests in this paper are collected from several sources. First, insurance companies' transactions and holdings of corporate bonds are obtained from the NAIC Schedule D files. Part 1 of the Schedule D data provide information on insurers' year-end bond holdings, including bond identification, holding size, and other accounting items. Parts 3 to 5 include insurers' transaction records with transaction date, bond identification, trade size, price, direction, and counter-parties.

Second, data on bond characteristics are from Mergent Fixed Income Security Database (FISD). This data set contains bond-specific information such as bond identification, issue and maturity dates, issue size, yield to maturity at issue, and coupon rate and payment frequency. In addition, Mergent FISD records historical bond-level credit ratings issued by S&P, Moody's, or Fitch. I determine a bond's credit rating according to the following rule used by the NAIC.[9] When all three rating agencies rate a bond, I use the middle rating. If two agencies rate a bond, I use the lower rating. If only one agency rates a bond, that single rate is used.

Third, I rely on Lehman Brothers Fixed Income Database (LSFID) to construct the market portfolio composed of investment-grade corporate bonds that are in the Lehman Brothers Bond

[9] See p.21 of https://www.naic.org/documents/committees_e_rea_wg_related_showing_all_fe_text.pdf.

Index.[10]

The fourth source of data is the Compustat North America database. I use the Fundamentals Annual data to construct the measure for a firm's dependence on long-term debt and a set of firm-level control variables. I resort to S&P Ratings data for firm-level credit ratings.

Merging the NAIC Schedule D and Mergent FISD is straightforward: The merge can be done through bond CUSIP available in both data sets. However, combining Mergent FISD and Compustat can be tricky. Although both data sets have CUSIP as the firm identifier, linking through CUSIP would not be accurate. The problem is that while Mergent FISD keeps the historical firm CUSIP as is when the firm issues a bond, Compustat only keeps the most recent firm CUSIP if a firm changes its CUSIP due to corporate actions such as acquisitions. The permanent firm identifier in Compustat is GVKEY. One approach suggested by WRDS Knowledge Base is to use the historical link between CUSIP and GVKEY provided in the S&P Ratings Xpress database.[11] The first step is to match the Mergent FISD issuer ID with the entity ID in S&P Ratings Xpress using CUSIP. Next, using the mapping between entity ID and GVKEY available in S&P Ratings Xpress, Mergent FISD can be combined with Compustat via GVKEY.

4 Changes in insurers' bond holdings after the RBC reform

As discussed in Section 2, because of the specific features embedded in the RBC rules, the impact of the RBC reform could manifest itself through prompting changes in insurance companies' investment behaviour. In particular, the RBC system leaves insurers space to reach for yield, thereby boosting insurers' demand for A-rated bonds. A-rated bonds are in the lowest tier of NAIC risk

[10]The index in renamed as Barclays Capital Bond Index after Lehman Brothers filed for bankruptcy in September 2008.

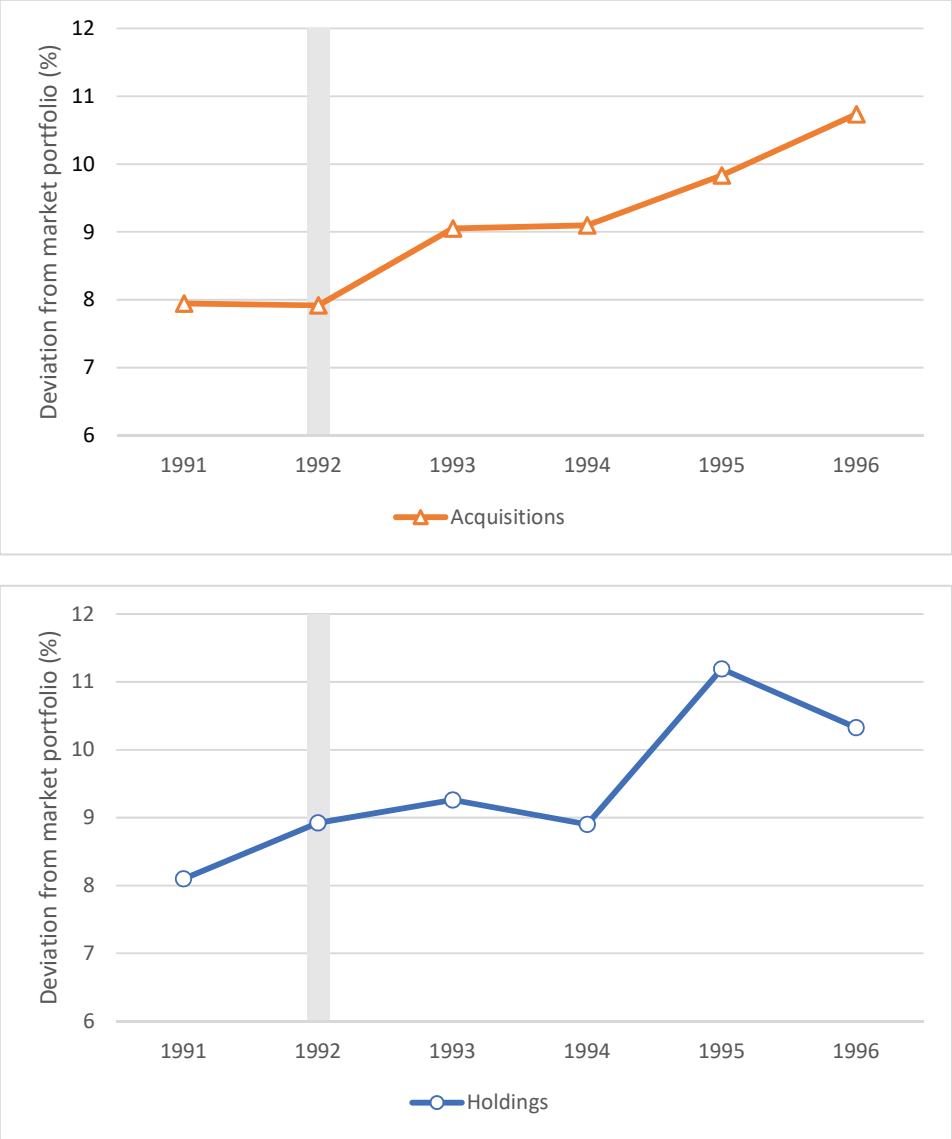
[11]Refer to the instructions from https://wrds-www.wharton.upenn.edu/pages/support/support-articles/mergent-fisd/linking-mergent-compustat-or-crsp/. WRDS log-on is needed.

category 1 and could render higher yields for the same amount of capital requirement. This section examines whether insurance companies indeed tilt their portfolios towards A-rated bonds following the RBC reform.

As aggregate evidence, I first compare the share of A-rated bonds in insurers' portfolios with that in the market portfolio. The graphs in Figure I trace the evolution of the difference in the share of A-rated bonds between insurers' portfolios and the market portfolio over the period from 1991 to 1996. These two time series of insurers' deviation from the market benchmark represent the extent to which insurance companies tilt towards A-rated bonds in their acquisitions of newly-issued bonds (the top graph) and in their bond holdings (the bottom graph). In the top graph of bond acquisitions by insurance companies when bonds are first issued in the primary market, the deviation measure stayed constant in 1991 and 1992 before the RBC is implemented. As indicated by the climb in the deviation measure over the post-RBC period (1993 to 1996), insurers showed tendency to put more weights on A-rated bonds in their investment choices at the time of bond issuance. A similar pattern is observed in the bottom graph of insurance companies' holdings of A-rated bonds in their portfolios. Altogether, Figure I provides suggestive evidence that the RBC reform induced a higher relative demand for A-rated bonds among insurance companies.

Table II offers a formal examination of the post-reform changes in insurance companies' bond portfolios. At the core of the empirical test in Table II is the assumption that insurers facing varying degrees of the RBC regulatory constraint have different amount of incentives to reach for yield following the RBC reform. I employ the A.M. Best's capital adequacy ratio (BCAR) as the measure of regulatory constraint. In the same spirit as the NAIC's RBC ratio, BCAR is the ratio of total adjusted capital to required risk-based capital, where both the available capital and

Figure I: Deviation of share of A-rated bonds in insurers' portfolios from market portfolio



Notes: The top graph plots the difference in share of A-rated bonds between insurers' acquisitions and market portfolio. Insurers' share is calculated as follows. First, for each insurer, I calculate the proportion of A-rated bonds in its purchase of new investment-grade bonds issued in the current year. Next, I take the median proportion among all insurers as the insurers' share. The market share is the proportion of all new investment-grade bonds issued in the current year that have a credit rating of A. The bottom graph plots the difference in share of A-rated bonds between insurers' holdings and market portfolio. Insurers' share is computed as the fraction of total holdings of A-rated bonds divided by total holdings of investment-grade bonds summed over all insurers. The market portfolio consists of all investment-grade bonds outstanding in the Lehman Brothers Fixed Income Database (LBFID). Given that the earliest Schedule D data becomes available in 1991, both series span the pre-RBC period (1991 to 1992) and post-RBC period (1993 to 1996).

Table II: Change in insurer' bond holdings following the RBC reform

Dependent variable:	Share of A-rated bonds in holdings		Share of A-rated newly-issued bonds in acquisitions	
	[1]	[2]	[3]	[4]
Post × BCAR Q1	2.10**	-	-0.47	-
	[0.93]	-	[2.60]	-
Post × BCAR Q2	1.75**	-	0.3	-
	[0.83]	-	[2.47]	-
Post × BCAR Q3	0.42	-	-3.16	-
	[0.85]	-	[2.37]	-
Post × BCAR Q4	0.16	-	-1.47	-
	[0.95]	-	[2.86]	-
Post × A	-	-3.37**	-	-7.62*
	-	[1.49]	-	[4.24]
Post × B	-	-2.34	-	-6.06
	-	[1.47]	-	[4.24]
Insurer controls	Yes	Yes	Yes	Yes
Insurer FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	3161	2795	1772	1621
R^2	0.94	0.94	0.83	0.83

Notes: This table reports results regarding post-RBC changes in insurers' bond portfolios. The sample period is from 1991 to 1996. The dependent variable in columns 1 and 2 is share of A-rated bonds in an insurer's portfolio. The dependent variable in columns 3 and 4 is share of A-rated bond as percentage of an insurer's total purchases of new bonds issued within a given year. The independent variables include interaction terms of proxies for an insurer's regulatory constraints with the dummy variable $Post$ that equals one starting from year 1993 and zero otherwise. In columns 1 and 2, the regulatory constraint is measured by an insurer's average BCAR over 1993 to 1996. Insurers are sorted into BCAR quintiles Q1 to Q5, where Q5 is the base group and include least constrained insurers. In columns 3 and 4, the regulatory constraint is proxied by an insurer's FSR in 1992. Insurer are grouped into those with FSR above A, between A and B, and below B. The base group is the below B group which is financially weak. Additional controls include insurer size (log of total bond value reported in Schedule D Part 1), portfolio duration (average bond duration), portfolio rating (average bond rating). All regressions include insurer and year fixed effects. Standard errors reported in brackets are clustered at the insurer level. The symbols ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

the required capital are computed using A.M. Best's formula.[12] Insurance companies with higher BCAR are considered to be better capitalized. Due to the data limitation that BCAR becomes available only starting from year 1993, I can't have a precise measure of an insurer's pre-reform regulatory constraint. Instead, I use an insurer's average BCAR over the years 1993 to 1996 as a proxy for its level of regulatory constraint. Insurance companies are sorted into quintiles (Q1 to Q5) based on their average BCAR. Group Q1 consists of insurers that are the most constrained (i.e., with the lowest BCAR), whereas group Q5 consists of insurers that are the least constrained (i.e., with the highest BCAR). The dependent variable of column 1 in Table II is the proportion of A-rated bonds in an insurer's portfolio. The regression includes insurer and year fixed effects, a set of controls including insurer size (log of total bond value reported in Schedule D Part 1), portfolio duration (average bond duration weighted by amount held), portfolio rating (average bond rating weighted by amount held),[13] as well as their interaction terms with the post-reform dummy (which equals one starting from year 1993, and zero otherwise). Standard errors are clustered at the insurer level.

The variables of interest are the interaction terms on the post-reform indicator and the BCAR quintiles. The result in column 1 of Table II indicates that the insurers that are more constrained by the RBC regulatory requirement have more incentive to reach for yield through shifting their portfolio towards A-rated bonds following the RBC reform. Compared to an insurer with BCAR in the top quintile (Q5), the share of A-rated bonds increases on average by an additional 2.10 percentage points for an insurer with BCAR in the lowest quintile (Q1), and 1.75 percentage points for an insurer with BCAR in the second lowest quintile (Q2).

[12] See http://www.ambest.com/ratings/bcar_lh.pdf for details on how BCAR is calculated.

[13] Each letter rating is assigned to a number. Specifically, AAA corresponds to 1, AA+ corresponds to 2, . . . , BBB corresponds to 9, and BBB- corresponds to 10.

Column 2 of Table II redoes the exercise in column 1 with an alternative measure for sorting insurance companies. The measure is A.M. Best's financial strength rating (FSR). First available in year 1992, A.M. Best's rating system provides an opinion of an insurer's financial strength and ability to meet its ongoing obligations to policyholders. The scale of FSR ranges from A++ to D, which corresponds to superior to poor financial strength.[14] Based on their pre-reform FSR in year 1992, insurance companies are grouped into those with FSR above A, between A and B, and below B. In column 2, I interact the post reform indicator with the FSR dummies. The result shows that the proportion of A-rated bonds decreases monotonically as the FSR increases. For an insurer with FSR above A, the share of A-rated bonds shrinks on average by an another 3.37 percentage points compared to an insurer with FSR below B.

To focus on insurers' investment behavior in the primary market, in columns 3 and 4 of Table II, I replace the dependent variable with the proportion of the newly-issued bonds acquired by an insurer that have a credit rating of A. I obtain significant results using FSR to sort insurers. Relative to an insurer with FSR below B, the share of A-rated bonds acquired by an insurer with FSR above A goes down on average by another 7.62 percentage point. Overall, the patterns in Table II confirm that the RBC reform is associated with insurers' reaching for yield behaviour, which is manifested by insurers' increased demand for the riskiest bonds within a given NAIC risk category.

5 The impact of the RBC reform on bond yield

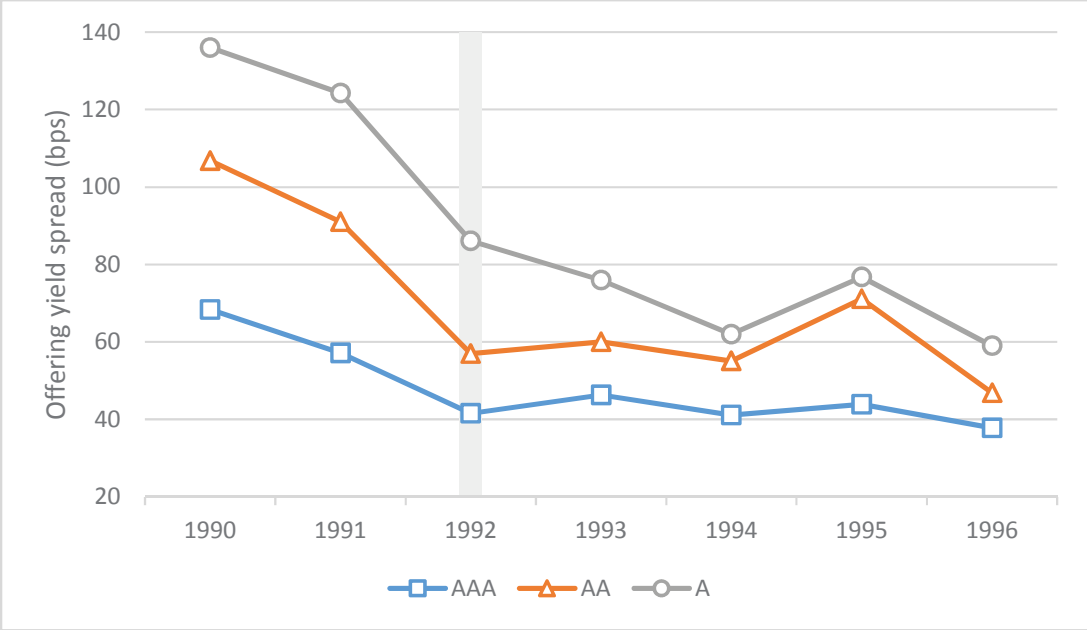
This section examines the impact of the RBC reform on risk premiums. Specifically, I test the hypothesis that RBC-driven shift in insurers' demand towards A-rated bonds documented in Section 4 would lower the risk premiums for A-rated bonds. I treat as the relevant risk premium the spread

[14] See http://www.ambest.com/ratings/guide.pdf for FSR category definitions.

between a bond's offering yield to maturity (reported in FISD at the time of issuance) over the closest benchmark Treasury.

In Figure II, I plot, respectively, the average offering yield spreads for newly issued bonds rated AAA, AA, and A in NAIC risk category 1 over the period from 1990 to 1996. Figure II provides visual evidence of the treatment effect of the RBC reform, which is consistent with insurers' increased demand for A-rated bonds. During the pre-RBC period (1990 to 1992), the yield spreads of the treatment group (bonds rated A) and control group (bonds rated AAA or AA) followed a parallel trend. However, over two years into the RBC regime (1993 to 1994), the yield spreads of A-rated bonds fell by 24 bps (from 86 to 62 bps), whereas the yield spreads of AAA and AA-rated bonds remained relatively flat.

Figure II: Average offering yield spreads



Notes: This figure plots the average offering yield spreads for newly issued bonds rated AAA, AA, and A, respectively, in NAIC risk category 1. The spread is calculated as the difference between a bond's offering yield to maturity (reported in FISD at the time of issuance) over the closest benchmark Treasury. The series spans the pre-RBC period (1990 to 1992) and post-RBC period (1993 to 1996).

Table III formally tests RBC's impact on bond yields with difference-in-difference regressions. Each observation corresponds to an individual newly issued bond over the sample period from 1990 to 1996. The dependent variable is the log of a bond's yield spread at the time of issuance over the closest benchmark Treasury. The dummy variable $Post$ is defined to be equal to one in years (1993 to 1996) after the RBC reform is initiated, and zero otherwise. In addition to bond credit rating dummies and their interaction terms with the reform dummy $Post$, I include a set of bond, issuer, and macroeconomic controls as in Campbell and Taksler (2003). The bond-level controls are log of issue size, years to maturity, and coupon rate. Time-varying issuer characteristics include financial health measures (pre-tax interest coverage and operating income to sales) and leverage measures (long-term debt to assets and total debt to capitalization). These measures are constructed using Compustat data. Pre-tax interest coverage is calculated as [operating income after depreciation (Compustat item oiadp) + interest expense (item xint)] divided by interest expense (item xint). As in Blume et al. (1998), four dummies are created to control for skewness in the distribution of pre-tax interest coverage. The four dummies are set to indicate whether pretax interest coverage is below 5, between 5 and 10, between 10 and 20, or above 20, respectively. Operating income to sales is the ratio of operating income before depreciation (item oibdp) to net sales (item sale). Long-term debt to asset is computed as total long-term debt (item dltt) divided by total asset (item at). The formula for total debt to capitalization is [total long-term debt (item dltt) + debt in current liabilities (item dlc)] divided by [total liabilities (item lt) + market value of equity (item csho $\times$ item prcc_f)]. All firm characteristics data are one calendar year prior to the firm's new bond issuance year. Furthermore, to capture the economic conditions, I include the level (2-year Treasury rate) and slope (10-year minus 2-year Treasury rate) of the term structure, as well as the TED spread (3-month London Interbank Offer Rate (LIBOR) minus 3-month Treasury rate). To account for

any time-invariant issuer characteristics and general macro trends in the data, I include issuer and year fixed effects. Standard errors are clustered at the issuer level.

Table III: The impact of the RBC reform on bond yield spreads

Dependent variable:	Yield spread			
	[1]	[2]	[3]	[4]
	NAIC 1	NAIC 2	NAIC 1 & BBB+	NAIC 1 & 2
Post × A	-0.34***	-	-0.34***	-0.21***
	[0.10]	-	[0.09]	[0.07]
Post × BBB+	-	-	-0.15	-
	-	-	[0.11]	-
Post × BBB-	-	-0.17*	-	-
	-	[0.09]	-	-
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1802	737	2094	2566
R^2	0.52	0.70	0.55	0.58

Notes: This table reports results regarding the RBC's impact on bond yield spreads of newly-issued investment-grade corporate bonds. The sample period is 1991 to 1996. The dependent variable is log yield spread between a bond's yield to maturity at the time of issuance over the closest benchmark Treasury. The independent variables are bond credit rating dummies and their interaction terms with the reform dummy $Post$, which equals one for years 1993 to 1996. The controls include bond-level, issuer-level, and macroeconomic variables. The bond-level controls are log of issue size, years to maturity, and coupon rate. Time-varying issuer characteristics (one calendar year prior to the issuer's new bond issuance year) include pre-tax interest coverage, operating income to sales, long-term debt to assets, and total debt to capitalization. Macroeconomic controls are the level (2-year Treasury rate) and slope (10-year minus 2-year Treasury rate) of the term structure, as well as the TED spread (3-month London Interbank Offer Rate (LIBOR) minus 3-month Treasury rate). All regressions include issuer and year fixed effects. Standard errors are clustered at the issuer level. The symbols ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

In Column 1 of Table III, the sample comprises of bond issues in NAIC risk category 1. The coefficient of interest is on $Post \times A$, which is the interaction term of the dummy variable for the reform and the dummy variable for A-rated bonds. This interaction term captures the difference-

in-difference effect on the yield spreads of A-rated bonds during the post-RBC era. The effect is statistically and economically significant. Consistent with the patterns depicted in Figure II, the coefficient estimate implies that the yield spreads of A-rated bonds fell by an additional 34% relative to other bonds in category 1 (i.e., bonds rated AAA or AA). In Column 2, I switch the sample to category 2 bonds and obtain qualitatively similar result as Column 1. Within category 2, bonds with the lowest rating (i.e., BBB-) experience an extra drop of 17%, compared with BBB+ or BBB bonds, as indicated by the significant coefficient estimate of $Post \times BBB-$, which is the interaction term of the dummy variable for the reform and the dummy variable for bonds rated BBB-. Column 3 looks at the sample consisting of bonds in category 1 as well as bonds rated BBB+. The specification in Column 3 exploits the discontinuity of the RBC rule at the boundary between two NAIC risk categories. Notice from Table I that the capital requirement on category 2 is over three times the category 1 requirement. Of particular interest is the difference in the coefficients on the interaction terms $Post \times A$ and $Post \times BBB+$. A Wald-test gives a F-statistics of 5.09, rejecting the null that the coefficients on $Post \times A$ and $Post \times BBB+$ are equal. Column 4 extends the sample to both category 1 and 2 bonds. The result shows that the yield spreads of A-rated bonds shrink by a greater amount (21% more) than all other investment-grade bonds.

Overall, the drop in yield spreads of A-rated bonds are consistent with insurers' boosted demand for A-rated bonds due to the sharp discontinuous increase in capital charges across NAIC risk categories and the loosely defined risk category covering a wide range of bond ratings. The results in Table III provide supporting evidence that the RBC could have an impact on credit pricing through insurers' distorted bond demand ascribable to the RBC's flawed design of risk categories not sensitive enough to risk. A further implication is that corporations who issue bonds that barely fit the criterion for low capital charges would be able to raise funds at lower costs.

6 The impact of the RBC reform on debt issuance

This section focuses on the impact of the RBC reform on debt issuance. To isolate RBC's effect, I apply a difference-in-difference estimation approach that studies differential post-RBC changes in debt issuance across not only firms' credit ratings but also their corresponding industries' varying degrees of dependence on insurance company funding prior to the RBC reform. Using the pre-reform dependence on insurer funding as an additional dimension of treatment intensity is inspired by Bertrand, Schoar, and Thesmar (2007), who study the impacts of the French banking reforms in the 1980. They construct an industry-level measure of banking dependence in the pre-reform period as a proxy for relative exposure to the banking reform.[15]

As the RBC reform induces a higher relative demand for A-rated debt among insurance companies, the identification assumption for the empirical approach is that A-rated firms which are more reliant on insurance company funding prior to the RBC reform would respond more to the shift in credit supply through increasing debt issuance. The major goal of this section is to provide direct evidence for this identification assumption that relies on firms' differing exposure to the RBC reform.

The measure of pre-reform dependence on insurance company funding is constructed at the industry level. Using data from the NAIC Schedule D and LBFID, the extent to which an industry relies on insurance company funding is defined as the fraction of total outstanding bonds that are held by all life insurance companies in each four-digit SIC averaged over the pre-reform years 1991 to 1992. Firm-level credit rating, debt issue, and accounting variables are extracted from Compustat. I use S&P's domestic long-term issuer credit rating (Compustat item splticrm) to categorize

[15] Another paper that constructs the treatment intensity variable with a similar taste is Hombert et al. (2020), who study the impact of the reform of French unemployment benefits.

firms. This rating reflects a forward-looking opinion of an obligor's overall creditworthiness.[16] As in Chaney et al. (2012), a firm's net change in long-term debt is computed as the yearly difference in long-term debt (item dltt) normalized by past year's property, plant, and equipment (PPE, item ppent). Net change in short-term debt is calculated as the yearly difference in debt in current liabilities (item dlc) scaled by lagged PPE (item ppent). I include additional firm-level accounting variables commonly used in the empirical studies on debt issuance (e.g., Badoer and James 2016, Chaney et al. 2012, and Leary and Roberts 2005). Specifically, these controls cover firm size, profitability, financial health, leverage, asset tangibility, and investment opportunity. Firm size is log of total assets (item at). Profitability is captured by return on assets, calculated as the ratio of operating income before depreciation (item oibdp) to assets (item at). Financial health are measured by pretax interest coverage dummies (defined in Section 5) and the ratio of cash flows (item dp + item ib) to assets (item at). Same as in Section 5, I use long-term debt to assets and total debt to capitalization as measures of leverage. Asset tangibility is computed as the ratio of PPE (item ppent) to assets (item at). Investment opportunity is measured by the ratio of book equity (common equity (item ceq) + deferred taxes and investment tax credit (item txditc)) to market equity (item prc_f$\times$item csho). Similar as Chaney et al. (2012), some of the above accounting ratios, including the ratio of fixed assets, the ratio of cash flows to assets, and the book-to-market ratio, are included as time-varying state variables in the debt issuance regression. The rest of the accounting variables are added to the regression as initial firm controls interacted with the post-reform dummy, where the initial firm characteristics are the average values over years 1970 to 1990.

[16]For details on S&P's issuer credit ratings, refer to https://www.standardandpoors.com/en_US/web/guest/article/-/view/sourceId/504352.

6.1 Main results

Table IV reports the results on the post-RBC changes in debt issuance for investment-grade firms across credit rating and differing degrees of reliance on insurance company funding. Each observation in sample corresponds to one firm and year over the period from 1991 to 1996. Following prior literature on capital structure, I exclude financial firms (with SIC codes 6000-6999). While columns 3, 4, and 6 focus on investment-grade firms rated A or higher, columns 1, 2 and 5 extend the sample to all investment-grade firms with credit ratings spanning from AAA to BBB. All regressions include initial and time-varying firm-level characteristics as controls, as well as firm and year fixed effects. Standard errors are clustered at the firm level.

Column 1 of Table IV starts with a simple estimation of the change in long-term debt with $Post \times A$, which is the double interaction term between the post-RBC dummy (which equals one for years 1993 to 1996, and zero otherwise) and the dummy for A-rated firm (which equals one for firms with credit rating of A, and zero otherwise). The result in column 1 reveals no significant difference in post-reform change in long-term debt between firms with a credit rating of A and firms in other credit rating tiers within the investment-grade category. However, this simple specification could mask a relative increase in long-term debt of A-rated firms that are the most exposed to the RBC reform, i.e., A-rated firms in industries that are more reliant on insurance company funding; and the relative decrease in long-term debt of A-rated firms that are least exposed to the reform. Therefore, to allow for differential effects, I add to column 2 the triple interaction term of the post-RBC dummy, the dummy for A-rated firm, and the firm's pre-RBC level of dependence on insurance company funding ($Post \times A \times InsurerDep$). The coefficient on the variable of interest in column 2, $Post \times A \times InsurerDep$, is positive and significant. This

Table IV: The impact of the RBC reform on debt growth

Dependent variable:	Change in long-term debt			Change in short-term debt	
	AAA/AA/A & BBB		AAA/AA/A	AAA/AA/A & BBB	AAA/AA/A
	[1]	[2]	[3]	[4]	[5]
Post × A	-0.02	-0.12**	-0.19**	0.06	0.06
	[0.02]	[0.06]	[0.09]	[0.06]	[0.07]
Post × A × InsurerDep	-	0.28*	0.38*	-0.17	-0.16
	-	[0.15]	[0.21]	[0.13]	[0.19]
Post × InsurerDep	-	-0.07	-0.13	0.19	0.17
	-	[0.10]	[0.19]	[0.12]	[0.20]
Initial controls × Post	Yes	Yes	Yes	Yes	Yes
Time-varying controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	2521	2521	1654	2521	1654
R^2	0.29	0.29	0.19	0.09	0.13

Notes: This table reports results regarding the RBC's impact on bond issuance of investment-grade corporate firms. The sample period is 1991 to 1996. The dependent variable of columns 1 to 3 is the net change in long-term debt. The dependent variable of columns 4 and 5 is the net change in short-term term. $Post$ is a dummy equal to one for years 1993 to 1996, and zero otherwise. A is a dummy equal to one for firms with credit rating of A, and zero otherwise. $InsurerDep$ is the fraction of total outstanding bonds that are held by all life insurance companies by industry averaged over the pre-reform years 1991 to 1992. All regressions control for firm initial characteristics (firm size, return on assets, pre-tax interest coverage, long-term debt to assets, total debt to capitalization) interacted with the $Post$ dummy, as well as time-varying firm characteristics (ratio of fixed assets, ratio of cash flow to assets, and book-to-market ratio). All regressions include firm and year fixed effects. Standard errors are clustered at the firm level. The symbols ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

indicates a relative post-reform increase in long-term debt among A-rated firms in industries that are more reliant on insurance company funding. In economic terms, long-term debt goes up by a relative 5% for a firm in an industry that is at the 75th percentile of the pre-reform dependence on insurance company funding compared to a firm in an industry that is at the 25th percentile.[17] Column 4 uses the same independent variables as column 2, but replaces the dependent variable with the change in short-term debt. As indicated by the statistically insignificant coefficients on the double interaction term $Post \times A$ and the triple interaction term $Post \times A \times InsurerDep$ in column 4, I don't find any significant change in short-term debt for A-rated firms after the reform. Furthermore, there is no significant indication of differential post-reform changes in short-term debt among A-rated firms in the more insurer-dependent industries. The findings in column 2 and 4 suggest that the impact of the RBC reform operates through driving long-term borrowing, which is consistent with the fact that life insurance companies invest in long-term assets to meet their long-term liabilities. I obtain qualitatively similar results when focusing on the subsample of firms rated A or higher: There exists differential growth in long-term debt among A-rated firms based on their industries' pre-reform dependence on insurance company funding (column 3); and there is no significant impact on short-term debt (column 5).

6.2 Heterogeneous effects: Ex-ante financial constraints

In this subsection, I further examine whether the post-reform change in long-term debt would be different for firms facing various extent of financial constraint. To investigate the role of financial constraint in shaping a firm's debt issuance response to the RBC reform, I first sort firms into two groups: one with more constrained firms, and the other with less constrained firms. Then, I re-

[17] Pre-reform insurance company funding dependence is 0.43 at the 75th percentile, and 0.26 at the 25th percentile. The relative increase of 5% is obtained from $(0.43 - 0.26) \times 0.28$.

Table V: The impact of the RBC reform on debt growth: by ex-ante financial constraints

Dependent variable:	Change in long-term debt					
	Payout policy		Cash flow		Firm size	
	constrained	unconstrained	constrained	unconstrained	constrained	unconstrained
	[1]	[2]	[3]	[4]	[5]	[6]
Post × A	-0.21***	0.02	-0.17**	0.01	-0.06	-0.19*
	[0.07]	[0.08]	[0.07]	[0.10]	[0.07]	[0.11]
Post × A × InsurerDep	0.49**	-0.09	0.39**	-0.04	0.17	0.43
	[0.20]	[0.19]	[0.19]	[0.23]	[0.16]	[0.28]
Post × InsurerDep	-0.11	-0.04	-0.07	-0.1	-0.15	0.02
	[0.13]	[0.09]	[0.12]	[0.14]	[0.11]	[0.18]
Initial controls × Post	Yes	Yes	Yes	Yes	Yes	Yes
Time varying controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1377	1144	1393	1122	1316	1205
R^2	0.32	0.16	0.31	0.2	0.34	0.19

Notes: This table reports results regarding the RBC's impact on bond issuance of investment-grade corporate firms separately for constrained and unconstrained firms. Three measures of financial constraints are used: dividend payout ratio (columns 1 and 2), ratio of cash flow to sales (columns 3 and 4), and firm size (columns 5 and 6). Firms with the constraint measure below (above) the median are classified as facing more (less) constraints. The sample period is 1991 to 1996. The dependent variable is the net change in long-term debt. $Post$ is a dummy equal to one for years 1993 to 1996, and zero otherwise. A is a dummy equal to one for firms with credit rating of A, and zero otherwise. $InsurerDep$ is the fraction of total outstanding bonds that are held by all life insurance companies by industry averaged over the pre-reform years 1991 to 1992. All regressions control for firm initial characteristics (firm size, return on assets, pre-tax interest coverage, long-term debt to assets, total debt to capitalization) interacted with the $Post$ dummy, as well as time-varying firm characteristics (ratio of fixed assets, ratio of cash flow to assets, and book-to-market ratio). All regressions include firm and year fixed effects. Standard errors are clustered at the firm level. The symbols ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

estimate the specification in column 2 of Table IV separately for the more constrained group and less constrained group.

Firms are grouped on the basis of three different measures of financial constraint used in Agrawal and Matsa (2013). I begin with dividing the sample of firms using their dividend payout ratio, which is computed as dividends (Compustat item dvc) divided by income before extraordinary items (item ibadj). Firms that keep more earnings (i.e., whose payout ratio is low) are considered to encounter greater financial constraint (Fazzari, Hubbard, and Petersen, 1988; Kaplan and Zingales, 1997). I also classify the firms based on their ratio of cash flow (item dp + item ib) to sales (item sale). A lower cash flow margin implies a higher level of financial constraint (Kaplan and Zingales, 1997). The third measure of credit constraint is firm size, which is proxied by sales (item sale). Smaller firms are thought to be more financially constrained (Hadlock and Pierce, 2010). I take the historical average of each measure over the period 1970 to 1990 as the ex-ante level of financial constraint. Firms with the constraint measure below (above) the median are classified as facing more (less) constraints.

As shown in Table V, for two out of the three measures of financial constraint (i.e., dividend payout ratio and cash to sales ratio), there exits heterogeneity in the post-reform change in long-term debt between the two groups of more constrained firms and less constrained firms. The estimated coefficient on the triple interaction term $Post \times A \times InsurerDep$ remains positive and significant only for the group of constrained firms. For instance, in column 1, within the group of firms whose dividend payout ratio is below the median, an A-rated firm in an industry that is at the 75th percentile of the pre-reform insurance company dependence distribution observe a relative increase of 8% in long-term debt compared with an A-rated firm in an industry that is

at the 25th percentile.[18] Hence, the findings in Table V indicate that the RBC reform induces a more pronounced change in long-term debt among firms with greater financial constraint, but has an insignificant impact on less constrained firms. In other words, there is evidence that the RBC reform relaxes financial constraints for firms that are ex-ante constrained.

6.3 Alternative treatment intensity variable

So far, I have used the pre-reform dependence on insurance company funding aggregated at the industry level as the baseline treatment intensity variable. Due to the data limitation that the NAIC Schedule D becomes available only from year 1991 onward, one might be worried that this variable could be somewhat loose or endogenous to the reform, as it is constructed using only two years of data immediately preceding the reform. To address this concern, I conduct the analysis employing an alternative variable to measure the strength of exposure to the RBC reform, which can be constructed based on data over a longer pre-reform period. This alternative definition of treatment intensity is the degree to which a firm relies on long-term debt prior to the reform.

The rationale for using long-term debt dependence to assess the intensity of exposure to the RBC reform is that life insurance companies, the largest participants in the corporate bond market, tend to invest heavily in long-term fixed income securities.[19] This is due to life insurers' need to align assets with their long-term insurance products (e.g., life insurance and annuities), which customers will make claims on or withdrawals from in the future. With this alternative variable for treatment intensity, the underlying identification assumption is that A-rated firms that are more reliant on long-term debt prior to the reform should be "more treated" by the shift in the supply of

[18] Pre-reform insurance company funding dependence is 0.43 at the 75th percentile, and 0.26 at the 25th percentile. The relative increase of 8% is obtained from $(0.43 - 0.26) \times 0.49$.

[19] According to Berends et al. (2013), life insurance industry's aggregate bond portfolio has an average maturity of 10.2 years.

credit brought about by insurers' changed investment behaviour after the RBC reform.

Similar to Foley-Fisher et al. (2016), the extent to which a firm relies on long-term debt is computed as the ratio of long-term debt (Compustat item dltt) to total debt, which is the sum of long-term debt and debt in current liabilities (item dltt + item dlc). To account for any endogenous movement due to the RBC reform, the long-term debt dependence ratio, denoted as $LtDep$, is averaged over the pre-RBC years 1970 to 1990.

In columns 1 and 2 of Table VI, I replicate the analysis of post-reform change in long-term debt in columns 1 and 2 of Table IV, respectively, using the firm-level dependence on long-term debt as the treatment intensity variable. I find qualitatively similar results as in Table IV. The double interaction $Post \times A$ alone in column 1 of Table VI is quantitatively small and statistically insignificant, indicating that there is no significant more change in long-term debt, on average, for A-rated firms after the reform. Column 2 of Table VI allows for differential effects based on a firm's pre-reform dependence on long-term debt. The positive and significant estimated coefficient on the triple interaction term $Post \times A \times LtDep$ confirms a relative post-reform increase in long-term debt among A-rated firms that are more dependent on long-term debt.

Using the pre-reform long-term debt dependence to measure the treatment intensity may raise one concern which has to do with the fact that during post-RBC period, the government issued less long-term debt. This could lead to an alternative interpretation that the more pronounced relative increase in long-term debt among A-rated firms that are more reliant on long-term debt may signal the gap-filling behaviour in corporate borrowing. That is, when the government issues less long-term debt, firms respond by tilting their debt issuance toward long-term debt (Greenwood et. al 2010; Badoer and James 2016). To address this source of concern, I control for the supply of long-term government debt, which is measured by the fraction of U.S. Treasury debt with a maturity of

Table VI: The impact of the RBC reform on debt growth: alternative treatment intensity variable

Dependent variable:	Change in long-term debt		
	[1]	[2]	[3]
Post × A	-0.04	-0.42*	-0.67***
	[0.03]	[0.22]	[0.25]
Post × A × LtDep	-	0.45*	0.70**
	-	[0.24]	[0.28]
Post × LtDep	-	-0.32*	-0.59***
	-	[0.17]	[0.22]
GovShare × A	-	-	-0.07
	-	-	[0.05]
GovShare × A × LtDep	-	-	0.08
	-	-	[0.05]
GovShare × LtDep	-	-	-0.08**
	-	-	[0.04]
Initial firm controls × Post	Yes	Yes	Yes
Time-varying firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	2777	2777	2777
R^2	0.3	0.3	0.3

Notes: This table reports results regarding the RBC's impact on bond issuance of investment-grade corporate firms, using an alternative treatment variable. The sample period is 1991 to 1996. The dependent variable is the net change in long-term debt. $Post$ is a dummy equal to one for years 1993 to 1996, and zero otherwise. A is a dummy equal to one for firms with credit rating of A, and zero otherwise. $LtDep$ is a firm's ratio of long-term debt to total debt, averaged over the pre-RBC years 1970 to 1990. $GovShare$ is the fraction of U.S. Treasury debt with a maturity of more than one year. All regressions control for firm initial characteristics (firm size, return on assets, pre-tax interest coverage, long-term debt to assets, total debt to capitalization) interacted with the $Post$ dummy, as well as time-varying firm characteristics (ratio of fixed assets, ratio of cash flow to assets, and book-to-market ratio). All regressions include firm and year fixed effects. Standard errors are clustered at the firm level. The symbols ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

more than one year. I obtain the annual time series of long-term government share from the Internet Appendix of Greenwood et al. (2010).[20] Column 3 of Table VI shows that the results are robust to inclusion of additional interaction terms involving the government share, since the estimated coefficient on the triple interaction term $Post \times A \times LtDep$ remains positive and significant.

7 The real effects of the RBC reform

The analysis in the previous sections has established that through shifting insurers' demand, the RBC reform have affected the cost and allocation of credit. In this section, I further investigate whether the RBC reform could carry real effects in the economy. In particular, I study whether the relaxation in outside financing after the RBC reform has allowed the reform's most "treated" group, i.e., A-rated firms in industries that rely more heavily on insurance company funding before the reform, to engage in more investment activities.

Table VII examines firm-level decisions. The variables I choose for firm decisions are capital expenditure, employment, cash holdings, and dividends and stock repurchases. Choice of these variables follows Foley-Fisher et al. (2016), who consider these four dimensions of firm decisions to study firms' response to the lower borrowing costs and increased credit availability brought about by the unconventional monetary policy after the 2008 financial crisis. On one hand, more capital expenditures and employees would support the hypothesis that firms take advantage of the increased availability of outside financing to expand investment and employment. On the other hand, more cash holdings or dividends and share buybacks would suggest firms' precautionary

[20]To construct this time series, Greenwood et. al (2010) decompose the stream of each outstanding Treasury issue's cash flows into a series of principal and coupon payments, using detailed bond information provided in CRSP U.S. Treasury Database. Every month, after adjusting for changes in the face value outstanding owing to repurchases or reopenings of an existing issue, payments due in upcoming n periods, are are aggregated across all outstanding issues. The long-term government share is computed as payments due in more than one year, divided by payments due in all future periods.

motives when good investment opportunities are absent. Conforming with the analysis in the previous section, the identification strategy relies on studying differential post-reform changes across firm credit ratings and industries with various pre-reform levels of dependence on insurance company funding. I use the same set of controls as employed in Section 6. These controls include time-varying state variables, as well as the initial firm characteristics interacted with the post-reform indicator. All regressions in this table include firm and year fixed effects. Standard errors are clustered at the firm level.

Columns 1 and 2 of Table VII report results for capital expenditure and employment, where capital expenditure and employment are measured in log growth rates of PPE (Compustat item ppent) and employees (item emp), respectively. I find that the expansion in employment is faster after the reform among A-rated firms that are more insurer-dependent. As indicated by coefficient on the triple interaction term $Post \times A \times InsurerDep$ in column 2, employment growth is up by about 3% on average among A-rated firms in industries at the 75th percentile of the pre-reform insurer funding dependence distribution compared to industries at the 25th percentile.[21] There seems no significant change in PPE growth in column 1. I will show in the next table that there is heterogeneity in the response of employment between the two groups of firms that are ex-ante constrained and unconstrained. The dependent variables in columns 3 and 4 are the log growth rates of cash holdings (item che) and dividends and stock repurchases (item dvt + item prstkc - item pstkrv), respectively. There is no indication that A-rated firms that are more insurer-dependent raise their cash holdings or increase their dividends or stock repurchases.

The specifications in Table VIII are the same as those in Table VII, but applied separately to

[21] Pre-reform insurance company funding dependence is 0.43 at the 75th percentile, and 0.26 at the 25th percentile. The relative increase of 3% is obtained from $(0.43 - 0.26) \times 0.19$.

Table VII: The real effects of the RBC reform

Dependent variable:	PPE	Employees	Cash holdings	Dividends
	[1]	[2]	[3]	[4]
Post × A	-0.04	-0.07**	0.08	-0.24
	[0.03]	[0.03]	[0.20]	[0.16]
Post × A × InsurerDep	0.04	0.19**	-0.14	0.52
	[0.08]	[0.08]	[0.50]	[0.44]
Post × InsurerDep	0.02	-0.05	-0.42	-0.44
	[0.07]	[0.05]	[0.30]	[0.36]
Initial controls × Post	Yes	Yes	Yes	Yes
Time-varying controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	2606	2558	2590	1734
R	0.44	0.42	0.1	0.18

Notes: This table reports results regarding the RBC's real effects on investment-grade firms' decisions. The sample period is 1991 to 1996. The dependent variables are log growth rates of PPE (column1), employees (column2), cash holdings (column3), and dividends and stock repurchases (column4). $Post$ is a dummy equal to one for years 1993 to 1996, and zero otherwise. A is a dummy equal to one for firms with credit rating of A, and zero otherwise. $InsurerDep$ is the fraction of total outstanding bonds that are held by all life insurance companies by industry averaged over the pre-reform years 1991 to 1992. All regressions control for firm initial characteristics (firm size, return on assets, pre-tax interest coverage, long-term debt to assets, total debt to capitalization) interacted with the $Post$ dummy, as well as time-varying firm characteristics (ratio of fixed assets, ratio of cash flow to assets, and book-to-market ratio). All regressions include firm and year fixed effects. Standard errors are clustered at the firm level. The symbols ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively.

Table VIII: The real effects of the RBC reform: by ex-ante financial constraints

Panel A: Constrained firms				
Dependent variable	PPE	Employee	Cash holdings	Dividends
	[1]	[3]	[5]	[7]
Post × A	-0.10**	-0.07**	0.28	-0.02
	[0.04]	[0.03]	[0.27]	[0.23]
Post × A × InsurerDep	0.22**	0.23**	-0.98	0.13
	[0.10]	[0.11]	[0.63]	[0.69]
Post × InsurerDep	-0.10	-0.08	0.03	-0.49
	[0.08]	[0.07]	[0.40]	[0.52]
Initial controls × Post	Yes	Yes	Yes	Yes
Time-varying controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1178	1241	1254	889
R^2	0.52	0.5	0.18	0.25
Panel B: Unconstrained firms				
Dependent variable	PPE	Employee	Cash holdings	Dividends
	[2]	[4]	[6]	[8]
Post × A	-0.04	-0.04	0.03	-0.21
	[0.04]	[0.07]	[0.48]	[0.19]
Post × A × InsurerDep	0	0.08	0.05	0.53
	[0.09]	[0.17]	[1.14]	[0.50]
Post × InsurerDep	0.08	-0.01	-0.93	0.23
	[0.07]	[0.10]	[0.75]	[0.33]
Initial controls × Post	Yes	Yes	Yes	Yes
Time-varying controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1404	990	1002	622
R^2	0.46	0.43	0.17	0.25

Notes: This table reports results regarding the RBC's real effects on investment-grade firms' decisions separately for constrained and unconstrained firms. The measure of financial constraint used is dividend payout ratio. Firms with the constraint measure below (above) the median are classified as facing more (less) constraints. The sample period is 1991 to 1996. The dependent variables are log growth rates of PPE (column1), employees (column2), cash holdings (column3), and dividends and stock repurchases (column4). $Post$ is a dummy equal to one for years 1993 to 1996, and zero otherwise. A is a dummy equal to one for firms with credit rating of A, and zero otherwise. $InsurerDep$ is the fraction of total outstanding bonds that are held by all life insurance companies by industry averaged over the pre-reform years 1991 to 1992. All regressions control for firm initial characteristics (firm size, return on assets, pre-tax interest coverage, long-term debt to assets, total debt to capitalization) interacted with the $Post$ dummy, as well as time-varying firm characteristics (ratio of fixed assets, ratio of cash flow to assets, and book-to-market ratio). All regressions include firm and year fixed effects. Standard errors are clustered at the firm level. The symbols ***, ** and * indicate significance levels at 1%, 5%, and 10%, respectively.

two groups of firms: one with firms that face greater financial constraint (below median dividend payout), and the other with firms that face weaker financial constraint (above median dividend payout.[22] Panel A focuses on more constrained firms, while panel B focuses on less constrained firms. The results in columns 1 to 4 suggest that there is heterogeneity in the response of investment and employment to the RBC reform across the two groups of constrained and unconstrained firms. As indicated by the positive and significant coefficient on the triple interaction term $Post \times A \times InsurerDep$ in columns 1 and 3, within the group of constrained firms, those with credit rating A and heavier pre-reform dependence on insurance funding experience relatively faster growth in PPE and employees. On average, PPE and employees growths both go up by about 4 percentage points for A-rated firms in industries at the 75th percentile of the pre-reform insurer funding dependence distribution compared to industries at the 25th percentile.[23] These are the same set of firms, documented in Section 6.2 that experience a relative increase in long-term debt. Collectively, the findings indicate that the relaxed access to outside financing after the RBC reform has allowed the most "treated" group of firms to raise debt issues and finance additional investment and employment.

8 Conclusion

In this paper, I study the economic consequences of the NAIC RBC reform in the insurance industry after 1993. The focus is on the RBC regulation that imposes capital requirements on life insurers' investment in corporate bonds, where the amount of capital charges is tied to NAIC risk categories defined by bond credit ratings. There are two salient features associated with the RBC

[22] I also repeat the tests using other group assignment criteria used in Section 6.2 that are based on firm cash flows or size. The results are qualitatively similar.

[23] Pre-reform insurance company funding dependence is 0.43 at the 75th percentile, and 0.26 at the 25th percentile. The relative increase of 4% in PPE (employment) growth is obtained from $(0.43-0.26)\times 0.22$ ($(0.43-0.26)\times 0.23$).

rule: (1) the sharp increase in capital requirements across risk categories, and (2) the broad range of bond ratings within a risk category. Using the NAIC data on insurers' corporate bond holdings, I first document changes in insurers' bond investment practices attributable to the above two features of the RBC rule. In particular, I find that, after the RBC reform, life insurers tilt their corporate bond portfolios towards A-rated bonds, which is the lowest tier of NAIC risk category 1. Next, I observe that the yield spreads on A-rated bonds experience a disproportionate drop after the RBC reform. Employing a difference-in-difference design where the treatment intensity is measured by firm rating and firms' pre-reform dependence on insurers' funding, I also observe a relative increase in long-term debt issuance among A-rated firms in more insurer-dependent industries. These findings suggest that through inducing a shift in insurers' bond demand, the RBC reform affects the supply of credit to individual firms in the economy. Last, I show that the increase in availability of outside financing driven by the RBC reform has benefited the group of A-rated firms in insurer-dependent industries, in that these firms are able take advantage of the credit supply conditions through increasing investment and employment. In sum, this paper demonstrates a mechanism through which regulatory reform on insurance companies can affect credit allocation and ultimately, real investment in the economy.

9 Reference

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